MASTER OF SCIENCE

CLINICAL OUTCOMES OF POST-OPERATIVE EXERCISE AND REHABILITATION FOR ELDERLY INDIVIDUALS FOLLOWING TOTAL KNEE ARTHROPLASTY
A QUASI-SYSTEMATIC AND NARRATIVE REVIEW

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CLINICAL OUTCOMES OF POST-OPERATIVE EXERCISE AND REHABILITATION FOR ELDERLY INDIVIDUALS FOLLOWING TOTAL KNEE ARTHROPLASTY: A QUASI-SYSTEMATIC AND NARRATIVE REVIEW

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LIST OF ABBREVIATIONS

1. TKA: Total Knee Arthroplasty
2. TKR: Total Knee Replacement (both TKA and TKR are the same)
3. THA: Total Hip Replacement
4. OA: Osteoarthritis
5. KOA: Knee Osteoarthritis
6. RA: Rheumatoid Arthritis
7. WHO: World Health Organisation
8. NHS: National Health Service (medical service of the UK)
9. PRISMA: Preferred Reporting Items for Systematic Review and Meta-Analysis
10. PRISMA-P: PRISMA Protocol
11. PICO: Patient, Intervention, Comparison, and Outcome
12. LOE: Level of Evidence
13. RCT: Randomise Controlled Trial
14. TUG: Timed Up and Go
15. QoL: Quality of Life
16. ROM: Range of Motion
17. STS: Sit-to-Stand
18. VAS: Visual Analogue Scale
19. WOMAC: Western Ontario McMaster Universities Arthritis Index
20. PA: Physical Activity
21. SCT: Stair Climbing Test
22. 10-MW: 10-Minute Walking
23. PT: Physical Therapy

DEDICATION

I would like to thank myself for endless inspiration and belief that brought me to where I am today and complete this thesis, even though there are issues and obstacles along the processes. I would like to dedicate this literature to people who have interested in improving quality of life for the elderly population. Hopefully, this study could be beneficial and useful to the next generation and to medical evidence in providing physiotherapist healthcare for the elderly patients.

ACKNOWLEDGEMENTS

First of all, I would like to thank the University of Dundee for making an offer and granting a Global Excellent Scholarship for me to study here.

Importantly, I would like to extend my heartfelt gratitude and appreciation to my supervisors from the Department of Orthopaedic and Trauma Surgery, School of Medicine, University of Dundee. First, Dr Andrew Murphy, who always willing to help me in every possible way and to encourage me to be the best version of myself. Thank you for unending support, advice, and effort to supervise me to learn and visualise how to conduct high-quality research and thesis. I am very grateful and appreciative for your guidance and assistance, both educationally and mentally during the lockdown period due to COVID-19 pandemic. Second, Dr Tim Drew, who was my primary supervisor during the first semester. I am very thankful for your kind supervision and guidance throughout my first semester. Thank you for always being kind and approachable, which make me feel comfortable whenever I want to have a discussion regarding my study and project. Besides, I would like to thank every staff in the faculty for giving lectures, teaching laboratory skills, and providing a helping hand whenever a student requires.

Finally, I would like to acknowledge my parents with gratitude. Thank you for always believing in me and allowing me to pursue what I am passionate about. This thesis would not have been possible without your support.

DECLARATION

I hereby declare that this thesis entitled “Clinical Outcomes of Post-operative and Rehabilitation for Elderly Individuals Following Total Knee Arthroplasty: A Quasi-Systematic and Narrative Review” has been prepared by me under the direct guidance of Dr Andrew Murphy and Dr Tim Drew as part of my study for the award of Master of Science by Research at the University of Dundee, Dundee, Scotland.

I have not submitted this thesis previously for the award of any degree or diploma at any other institution.

Enter Date Here Thursday, 17th September 2020	Sign Your Name Here

COVID-19 PANDEMIC

A special note regarding the COVID-19 pandemic. Written by Dr Andrew J Murphy, Lecturer, University of Dundee Department of Orthopaedic and Trauma Surgery, on 21 July 2020. In late 2019 and throughout 2020 severe disruption was caused to many aspects of life across the world. From late February 2020 the work presented here was affected by this disruption.

The student, Korranat Amornrattanaroj, who undertook the current project has shown admirable fortitude in the face of serious disruption to his work. Korranat had originally taken on the challenge of delivering an entirely different project to the one presented here and after working well for approximately five months was forced to radically change his focus and essentially begin a new project from scratch after the COVID-19 pandemic hit the UK in earnest. At the time the project had to be abandoned its working title was *biomechanical analysis of force distribution and injury risk during lay-up manoeuvres in basketball*, the success of that project would have been critically dependant upon having continuing access to the specialist laboratories and training facilities housed within the University of Dundee, as well as permission to work closely with human participants (whom he had already recruited).

After the disappointment of the forced cancelation of his original project Korranat worked hard under exceptionally difficult professional and personal circumstances to devise and deliver the project presented in this document, and both I and his thesis monitoring committee have been impressed by his handling of the situation. I write this note with the hope of ensuring that the University of Dundee no detriment policy is borne in mind when the work is assessed by internal and external examiners.

ABSTRACT

Increasing number of the elderly population nowadays raised concern in medical care in the field of the physiotherapist. Due to the frailty of physical condition, ageing in this population tends to develop arthritis in the weight-bearing joints, specifically the knees. The elderly patients were thereby being hindered from pain-free mobility and physical independence. Surgical intervention of total knee arthroplasty (TKA) should be implemented to treat the joint pain condition. Post-operative exercise and rehabilitation following operation are required to enhance the physical recovery process at post-surgery. This study was conducted in a quasi-systematic and narrative review, utilising relevant existing literature provided on electronic databases. Based on the retrieved result from included studies, balance and resistance training are the most common intervention programmes that applied to patients. At post-intervention, the elderly patients exhibited an improvement in clinical outcomes, additionally with functional outcomes. However, some studies revealed adverse outcomes of worsening in the operated knee joint from post-operative exercise and rehabilitation. In conclusion, currently, no universal gold standard protocols for these intervention programmes regarding physiotherapist for the elderly population are available due to limited existing literature; however, balance and resistance training are only two interventions that show positive effects with zero detrimental outcomes reported. Therefore, this study primarily focuses on the clinical, as well as functional outcomes of physical recovery after the utilising of such interventions, to visualise feasible and safe rehabilitation programmes suitable for, specifically, the elderly patients underwent TKA.

Keywords: total knee arthroplasty, elderly, post-operative exercise, physical therapy, rehabilitation.

CHAPTER 1

1.1 INTRODUCTION

The elderly population are subjected to be increasing every year in the UK. To clarify, according to the World Health Organisation's (WHO) definition of elderly, individuals whose age are 65 or over were classified as the elderly (WHO, 2010). According to Matheson (2010), the proportion of the population in the UK between 1984 and 2009 who were aged 65 and over has increased from 15% to 16%. However, as shown in *Table 1.1*, it is projected that proportion of people aged 65-84 could rise to 18%, and 85+ and above could rise to around 5% of the total UK population by 2034 (Matheson, 2010). Besides the UK, the rising of the elderly population across the world is growing continually (Christensen, Doblhammer, Rau, & Vaupel, 2009). The world demographic data showing the number of the elderly population from 2000 to 2019 were based on the World Bank data, as shown in *Figure 1.1*.

	1984		**2009**		**2034**	
Age group	Population (millions)	*Percent*	Population (millions)	*Percent*	Population (millions)	*Percent*
0-15	11.9	*21*	11.5	*19*	12.8	*18*
16-64	36.1	*64*	40.1	*65*	42.5	*59*
65-84	7.7	*14*	8.7	*14*	13.2	*18*
85+	0.7	*1*	1.4	*2*	3.5	*5*
All	56.4	*100*	61.8	*100*	72.0	*100*

Table 1.1 Estimated and projected population and percentage of population by age group UK, 1984, 2009 and 2034

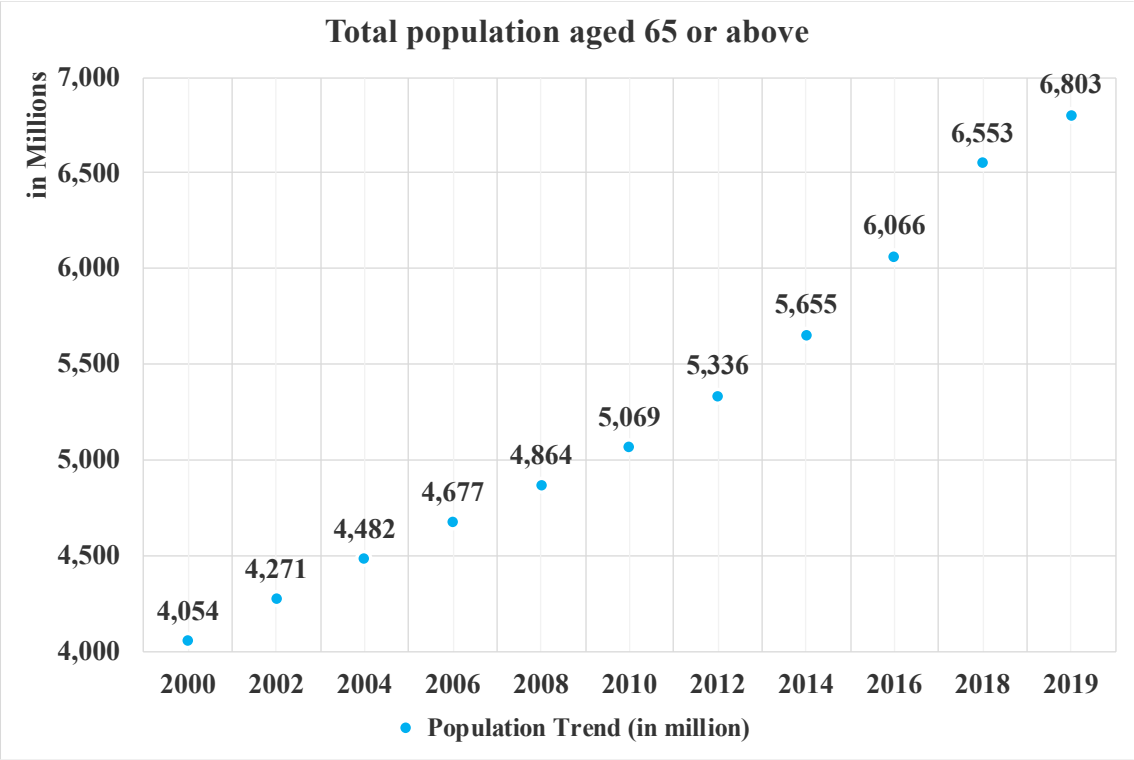


Figure 1.1 World Bank's total number of the elderly population of the United Nations Population Division's World Population Prospects, retrieved from The World Bank (2019).

As the number of the elderly population rises, it is vital to raise a concern of physical healthcare in the elderly as this group of the population is highly vulnerable to musculoskeletal diseases and injuries due to ageing (Siparsky, Kirkendall, & Garrett, 2014). It is crucial to keep in mind that immobilisation and inactivity have more deleterious effect in the elderly than in younger adults (Kallinen & Markku, 1995).

Musculoskeletal disorders are commonly prevalent in the elderly population (Wolff, Starfield, & Anderson, 2002). Pathologically, while ageing, the musculoskeletal tissues show the loss of cartilage resilience, increased bone fragility, reduced elasticity of ligament, weakened muscular strength and redistributed fat that decreases the ability of musculoskeletal tissues to function normally (Freemont & Hoyland, 2007). Ageing could lead to age-related musculoskeletal diseases in the elderly population, while one of the most common joint disorders for individuals aged over 65 years is osteoarthritis (OA)

(Shane Anderson & Loeser, 2010). Knee osteoarthritis (KOA) in the elderly population is solely accounted for 83% of total OA burden globally (Vos et al., 2012).

KOA is considered to be one of the most common musculoskeletal disorders among the elderly population (Minetto et al., 2020). Risk factors contributing to the cause of knee osteoarthritis, including age, female sex, obesity, and history of knee injury (Silverwood et al., 2015). Additionally, knee malalignment is considered to be a strong risk factor for osteoarthritis (OA) (Runhaar et al., 2014). According to Morgan et al. (2019), knee osteoarthritis cases reported by the National Health Service (NHS) in the UK has the highest prevalence comparing to other types of OA such as foot, hands, and hip annually from 2012/2013 to 2017/2018 with more than 100,000 cases among the elderly population aged 65+, plus distribution of knee OA exhibit the highest peak for the elderly patients aged of 70 – 74 years.

Prolonged knee osteoarthritis (KOA) could result in difficulty in performing daily activities, pain, reduced physical independence, and worsen the patients' quality of life (QoL) (Munugoda et al., 2020). Thus, surgical intervention may be required to alleviate and treat the knee OA condition (Kennedy, Johnston, Cochrane, & Boscainos, 2013). Total knee arthroplasty (TKA) or total knee replacement (TKR) is one of the most common orthopaedic procedures for treating rheumatic arthritis (RA) of the knee or end-stage KOA where the articular surfaces of the femur and tibia were replaced by femoral and tibial metal component (Medical Advisory, 2005) to relieve joint pain and stiffness (Li, Ma, & Xiao, 2019), hence increasing mobility of the joint and improving the QoF (Feng, Novikov, Anoushiravani, & Schwarzkopf, 2018). Moreover, TKR for osteoarthritic patients shows significant improvement of function and pain reduction in

the elderly population in general but exhibits the lowest positive outcomes of functional score among patients aged 80 years and older (Medical Advisory, 2005).

This aforementioned surgical treatment was commonly performed in the elderly population to replace the damaged knee (Kennedy et al., 2013). According to Papalia et al. (2020), at post-operation, implementation of physical intervention programmes for recovery of pre-operative exercises and rehabilitation are essential for the recovery of physical function following total knee arthroplasty (TKA). These interventions are usually applied to elderly patients where appropriate regarding their physical limitations while performing such activities. According to Christiansen et al. (2020), a physical therapist-administered physical activity intervention is safe and feasible for the elderly patients; thus exhibit an increase in steps/day and spending 73.4 more minutes/week after 6-month of intervention. Moreover, Papalia et al. (2020) have also suggested that even though there are a limited amount of available studies in this field, heterogeneity of rehabilitation processes and outcome measures which are unable to draw definitive conclusions, most studies have shown that the elderly patients with TKA could benefit from physical activity and aquatic therapy.

When applying a physical rehabilitation programme to this specific group of the population, there are many factors which should be concerned regarding the safety and physical limitations. According to Papalia et al. (2020), cycle ergometer is controversial and not beneficial in post-TKA recovery for the elderly patients. Even though the results indicate an improvement in strength and proprioception, but the training could overload the operated knee, thus inducing soft-tissue oedema, and joint effusion (Liebs et al., 2010). Therefore, due to a limited number of studies provided, the optimal level of intervention is inconclusive according to different types of intervention also.

The research regarding physiotherapy at post-operation is relatively lacking as the result of clinical and functional outcomes are inconclusive (Piva et al., 2019) (Papalia et al., 2020). More research can be conducted to analyse the outcomes of different types of post-operative exercise and rehabilitation in the elderly population undergone TKA in order to develop further knowledge, explanations, and reliable consensus to deliver the best possible physiotherapist programmes for the elderly patients. Ultimately, the final results from this study can be used to develop the guidelines for medical staffs, clinicians, physiotherapist, and researchers in order to provide the safe and practical approach to implement appropriate intervention programmes of post-operative exercise and rehabilitation during the recovery period at post-operation without causing harm to, specifically, the elderly patients underwent TKA.

1.2 AIMS & OBJECTIVES

This quasi-systematic review and narrative review aims to add to the existing body of literature in the field of physiotherapy and sports medicine. The primary objective of the current study was to apply the fundamental principles of a systematic review and narrative review in order to produce research evidence regarding the field of physiotherapist conducted in a quasi-systematic review and narrative review, trying to combine all possibly relevant studies on post-operative exercise and rehabilitation specifically in the elderly patient undergone TKA.

This study will integrate up-to-date and reliable literature regarding physiotherapy in the elderly population undergone total knee arthroplasty. To consolidate the most appropriate type of physical activity that is suitable for the elderly to perform without causing harm as this group of population is highly vulnerable to physical injury comparing to the younger age groups.

Ultimately, this study will represent high-quality and up-to-date literature which could be a beneficial source in clinical decision making. To provide the best possible healthcare in physiotherapy for the elderly population undergone TKA to recover physical function and regain physical independence by utilising the application of physical therapy and exercise medicine.

CHAPTER 2

2.1 METHODS

This study is a quasi-systematic and narrative review, which the protocols were exampled from a systematic review and meta-analysis. A quasi-systematic review aims to collect and analyse the studies of interested, which were conducted by previous researchers, while narrative reviews are mainly descriptive, and not involving a systematic search of the literature (Bae, 2014). Extensively, narrative review often includes an element of selection bias due to the nature of the study. Therefore, utilisation of the methodology from conducting a systematic review and meta-analysis could be useful as a guideline based on the justified logical method (Uman, 2011).

A systematic review was conducted with a detailed and comprehensive plan with a clear illustration of the search strategy. Elaboratively, a systematic review attempts to gather all relevant pieces of evidence according to eligibility criteria to answer a specific research question whilst a meta-analysis combined statistical techniques to combine and summarise the results of multiple studies selected and this method is reasonable to encompass together with a systematic review (Moher et al., 2015). A proper systematic review should include a pre-defined clinical question, specified inclusion and exclusion criteria, advanced searching for medical evidence sources according to a search strategy, critical evaluation of the reliability of clinical trials, qualitative or quantitative data synthesis, and conclusion of evidence-based (Rys, Wladysiuk, Skrzekowska-Baran, & Malecki, 2009).

To simplify, the methodology of conducting a quasi-systematic review and narrative review was derived and adapted from the rationale in accordance with systematic review and meta-analysis and was listed as eight stages shown below.

1. Formulate the review question – starts by forming hypotheses and developing a title of interested.

2. Define inclusion/exclusion criteria – using an acronym PICO (Eriksen & Frandsen, 2018), which stands for Population, Intervention, Comparison, and Outcomes, respectively. This approach is useful to ensure all key components prior beginning of the review.

3. Develop a clearly defined search strategy – before running a search of electronic databases; it is crucial to come up with a comprehensive list of keywords and terms. The most important aspect of this stage is to retrieve a high proportion of relevant studies with a low proportion of irrelevant studies with specificity.

4. Select studies of interested – once all retrieved studies have been reviewed, any studies appearing to meet inclusion criteria will be categorised for full-text assessment and analysis. Generally, this process of reviewing is done by at least two investigators/assessors to establish inter-rater reliability. ***However, this quasi-systematic review and narrative review has one investigator due to study limitation, providing multiple screenings could be useful for a single researcher to minimise the potential of error.***

5. Extract data – one of the best approaches to synthesise data is to form a table, which helps organise extracted information from reviewed studies. Beneficially, data extraction by at least 2 or more investigators is essential for establishing inter-

rater reliability and avoiding errors from data entry. *In this study, an assessor has to perform multiple reviewing to avoid mistakes in data entry.*

6. Assess the quality of studies – there are 2 main approaches in this study, which are the utilisation of Physiotherapy Evidence Databased (PEDro) Scale to assess to quality for randomised controlled trials (RCTs) studies (Albanese, Butikofer, Armijo-Olivo, Ha, & Egger, 2020) and modification of protocol to examine bias of studies by using Cochrane Risk of Bias Assessment (Higgins et al., 2011).

7. Analyse and interpret results – in this narrative review, effects of intervention will be reported in tables and explained without employing statistical programmes for analysis.

8. Disseminate findings – summaries should be explained in plain language for better clarification of the results.

This quasi-systematic review and narrative review were conducted in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines (Liberati et al., 2009) and PRISMA Protocol (PRISMA-P) (Moher et al., 2015). PRISMA-P was developed as a guideline for preparation of protocols for systematic review and meta-analysis, which intended to provide the rationale, methodological plan, and analytic approach prior conducting a review (Moher et al., 2015). All in all, this study conducted to discuss and extract data and results from summarisation in pre-existing studies regarding post-operative physiotherapy in the elderly population undergone TKA that was accomplished by the previous researchers (Rodrigues, Santos, Arnaud, & Souza, 2013). This study utilised the PRISMA-P model

as a guideline for data extraction and analysis, by following the systematic methods to minimise bias in the identification, selection, synthesis, and summary of eligible studies.

2.2 RESEARCH QUESTION

PICO framework has the potential to improve the efficiency of literature searching as the specific research question is clear and precise (Schardt, Adams, Owens, Keitz, & Fontelo, 2007). The reason of utilising PICO framework in generating the specific clinical research question is because the platform could provide a better focus of the question, which contribute to a better specificity in findings (Methley, Campbell, Chew-Graham, McNally, & Cheraghi-Sohi, 2014).

The PICO platform in this study will be explained on how the process of generating the specific research question was implemented.

1. Initially, when assessor was looking at the population (P) of interested, this study has focused on a group of the elderly population aged 65 years or over who underwent total knee arthroplasty (TKA), regardless of the specific joint disease.
2. Secondly, the intervention (I) programmes or recovery programmes after TKA, which this study wants to focus on are post-operative exercise and rehabilitation.
3. Thirdly, to examine an improvement among the participants, patients will be divided into two groups for comparison (C); those who did take intervention programmes and those who did not take intervention programmes for recovery at post-surgery.
4. Finally, clinical and functional outcomes (O) of all assessed studies combined will be reported in tables of results, discussed, and explained by data obtained from included studies.

2.3 INCLUSION AND EXCLUSION CRITERIA

Studies found to be relevant, including total knee arthroplasty (TKA), elderly patients, and any physical activities for recovery will be eligible for full-text analyses. Inclusion and exclusion criteria were the baselines for selecting eligible studies, which will be used to report and extract data in this study.

Eligibility of each study was selected if inclusion criteria were met as listed below:

1. According to the WHO definition of elderly, only studies with the average age of cohorts' superior to 65 years were considered.
2. Elderly patients have undergone total knee arthroplasty (TKA), either bilateral or unilateral or both were eligible.
3. Intervention programmes, including physical therapy, post-operative exercises, and rehabilitation, were applied for elderly individuals following total knee arthroplasty (TKA).
4. The studies combined total hip arthroplasty (THA) with total knee arthroplasty (TKA) are eligible – if the physical rehabilitation were applied, and studies results of two groups were reported separately.

Studies were dismissed regarding full-text analyses and assessments following the exclusion criteria listed below,

1. Patients with knee osteoarthritis did not undergo total knee arthroplasty (TKA).
2. Mean age of patients/participants in the study are < 65 years, and the study with high variability of patients' age.
3. No implementation of the post-operative exercise and rehabilitation interventions for the elderly patients but focusing on the outcome after the surgical treatment only.

4. The pre-operative exercise was the main emphasis of that study.
5. The study is focusing on the perceptions, psychological factors, and behavioural changes prior and following total knee arthroplasty (TKA).

2.4 OUTCOME OF INTERESTED

The primary outcome was to assess the effects of post-operative exercise and rehabilitation on clinical outcomes following total knee arthroplasty (TKA), measured by validated and subjective clinical measurements. Clinical outcomes of interested in being considered in this study at post-intervention results are Timed Up and Go (TUG) test, Range of Motion (ROM), muscular changes in operated legs, Sit-to-Stand (STS) time, Quality of Life (QoL), Visual Analogue Scale (VAS) and Western Ontario McMaster Universities Arthritis Index (WOMAC). Additionally, there are functional outcomes of interested to be included in this study, including changes in Physical Activity (PA) level, and other factors. All factors were explained and elaborated below,

1. Timed Up and Go (TUG) test – utilise in the assessment of static and dynamic balances, and participants' mobility. This test measures the time takes to rise from the chair, 3-metre walk, turn around, walk back to the chair, and sit down (Kear, Guck, & McGaha, 2017). It is a safe, reliable, and time-efficient way to evaluate overall functional mobility.
2. Range of Motion (ROM) – a measurement in degrees of joint movement during active and passive, to assess improvement in the arc of joint motion (Soucie et al., 2011).
3. Muscular changes in operated legs – to observe a strengthening of the muscles in an operated leg, such as quadriceps and hamstrings peak torque and increasing in muscle volume after completion of the intervention.
4. Sit-to-Stand (STS) time – 5-repetition sit-to-stand test is performed to assess the lower limb function during 5-time sit-to-stand to record the fastest time taken of participants to rise from a chair with arms folded (van Lummel et al., 2016).
5. Visual Analogue Scale (VAS) – a subjective measurement of pain (both acute and chronic) (Delgado et al., 2018). It is widely used due to its adaptability to a broad

range of populations and settings. VAS measurement is sensitive to a small change of agonised symptoms, which the pain outcomes could be recorded as mild, moderate, and severe.

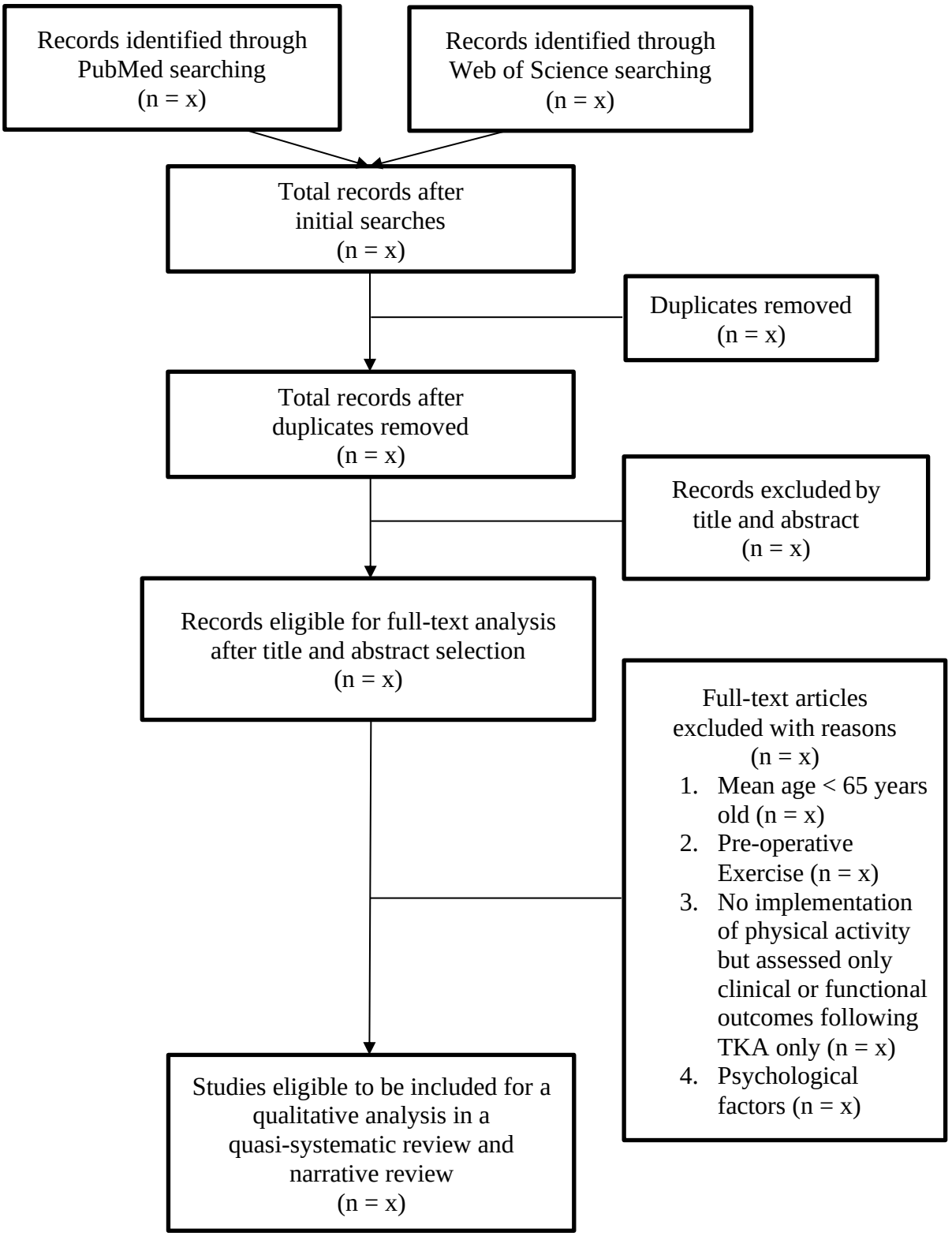
6. Quality of Life (QoL) – it is a multidimensional measurement of participants will-being after receiving treatment. To assess the satisfaction after completing all interventions. This measure is important and useful for medical improvement and disease management for participants with chronic pain condition (McPhail & Waite, 2014).
7. Western Ontario McMaster Universities Arthritis Index (WOMAC) – an assessment which is commonly used to evaluate hip and knee osteoarthritic conditions, such as osteoarthritis, rheumatoid arthritis, fibromyalgia, systemic lupus erythematosus, and lower back pain. Moreover, area of assessment by WOMAC index, including daily living activities, functional mobility, gait improvement, physical health, and QoL.
8. Physical Activity (PA) level – to assess an increasing of time spending on physical activity and improvement in exercise intensity level.

2.5 SEARCH STRATEGY FOR IDENTIFICATION OF THE STUDIES

PubMed and Web of Science were searched for relevant articles. Article searching was carried out during June and July 2020. The search string used for PubMed advanced search was the following: All Fields = ((("knee osteoarthritis" or "osteoarthritis" or "knee pain") AND ("older" or "elderly")) AND ("total knee arthroplasty" or "total knee replacement" or "knee surgery")) AND ("physical therapy" or "physical activity" or "prehabilitation" or "rehabilitation" or "physical rehabilitation" or "aquatic rehabilitation" or "preoperative exercise" or "postoperative exercise" or “exercise"). The search string used for Web of Science advanced search was the following: TS = ((("knee osteoarthritis" or "osteoarthritis" or "knee pain") AND ("older" or "elderly")) AND ("total knee arthroplasty" or "total knee replacement" or "knee surgery")) AND ("physical therapy" or "physical activity" or "prehabilitation" or "rehabilitation" or "physical rehabilitation" or "aquatic rehabilitation" or "preoperative exercise" or "postoperative exercise" or “exercise"). Searches were limited to paper published in English, but no time interval was set for the year of publication.

Retrieval of studies from electronic databases was illustrated and shown step by step in a flowchart diagram in *Figure 2.1*.

Figure 2.1 Flowchart illustrates the steps of study retrieval from databases.



2.6 DATA EXTRACTION

Extracted data were categorised into tables showing the name of each study, type of study and level of evidence (LOE), types of orthopaedic procedure, mean age of patients, number of patients, different types of post-operative exercise and rehabilitation, period of intervention programmes, clinical and functional outcomes of physiotherapy intervention following total knee arthroplasty (*Table 3.1 – Table 3.7)*. Types of physiotherapist intervention, clinical and functional outcomes from each study will be explained in detail separately following the table of summary.

2.7 QUALITY ASSESSMENT

Quality assessment was performed following the Physiotherapy Evidence Database (PEDro) Scale (Maher, Sherrington, Herbert, Moseley, & Elkins, 2003) to select and categorise eligibility of each randomised controlled trials (RCTs) that were included in this review. All randomised controlled trial studies were assessed by 11 scoring criteria from the PEDro Scale (Albanese et al., 2020). PEDro scale to assess the study quality in physiotherapist was composed of 11 checklists (Maher et al., 2003) (de Morton, 2009) (Albanese et al., 2020).

1. Eligibility criteria were specified
2. Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)
3. Allocation was concealed
4. The groups were similar at baseline regarding the most important prognostic indicators
5. There was blinding of all subjects
6. There was blinding of all therapists who administered the therapy
7. There was blinding of all assessors who measured at least one key outcome
8. Measurements of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups.
9. All subjects from whom outcome measurements were available received the treatment or control condition as allocated, or where this was not the case, data for at least one key outcome were analysed by “intention to treat”.
10. The results of between-group statistically comparisons are reported for at least one key outcome.
11. The study provided both point measurements and measurements of variability for at least one key outcome.

Studies in the form of systematic review and meta-analysis were reported in narrative review, utilising the risk of bias assessment to minimise potential bias. Apart from randomised controlled trial studies were not qualified to be included in the PEDro scale assessment.

2.8 RISK OF BIAS

The bias of included studies was assessed following the risk of bias guidelines (Meera Viswanathan et al., 2013). To enhance the strength of bias assessment, the Cochrane Collaboration's tool for assessing the risk of bias (Higgins et al., 2011) was also implemented in this process. In this study, risk of bias was categorised and constructed were relevant and in accordance with the PEDro scale for quality analysis. The criteria were classified into bias in blinding, the bias in random allocation, bias in allocation concealment, diversity in participants, and funding of the study. However, the risk of bias has no standard protocol to follow, which the criteria could be generated by researchers/assessors where appropriate and in accordance with the included study. The risk of bias in this quasi-systematic review and narrative review based primarily from the critical appraisal of PEDro scale analyses.

CHAPTER 3

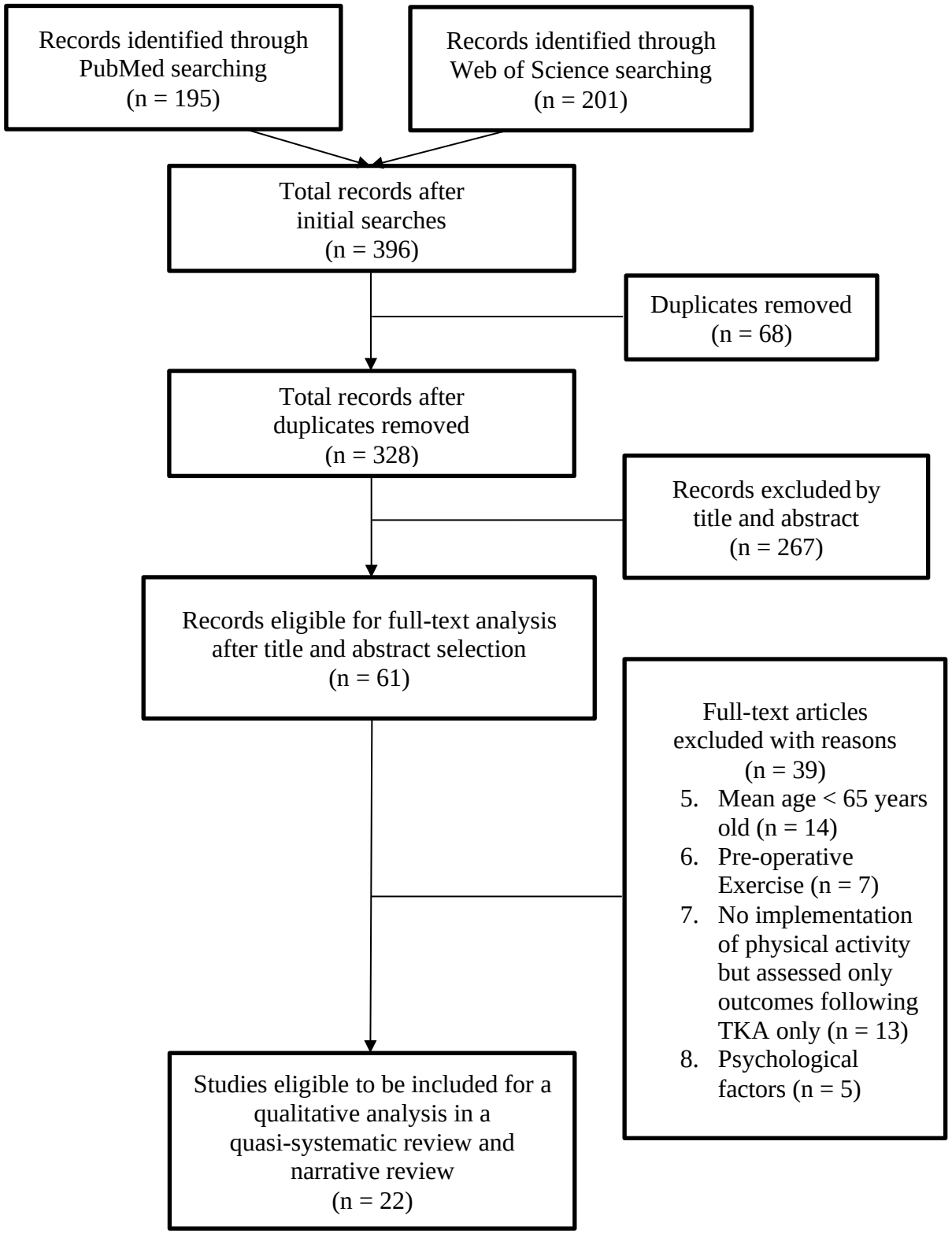
3.1 RESULTS

The results and outcomes extracted from studies analyses were illustrated and reported into tables, which divided into the table of results of post-operative exercise and rehabilitation outcomes (*Table 3.1 – Table 3.7)*, PEDro scale to assess the quality of included studies *(Table 3.8 and Table 3.9)*, and an overall bar graph showing the risk of bias assessment *(Figure 3.2)*.

3.2 RESULTS OF ELECTRONIC DATABASE SEARCHING

Electronic database searching was retrieved from PubMed and Web of Science. Using the keywords for advanced searching in order to obtain a high proportion of relevant studies with specificity while obtaining a low proportion of irrelevant studies. Total findings from two databases were firstly screened the title, where the duplications of studies were removed. Records remained after duplications were removed will be read through the title and abstract and find the relevancy of each study that will be eligible for full-text assessment. After receiving a number of relevant studies, each study will undergo full-text analyses were the inclusion and exclusion criteria were implemented to find eligible studies to include in this quasi-systematic review and narrative review. The number of studies retrieved from electronic databases and processes, as illustrated in the flowchart *(Figure 3.1)*.

Figure 3.1 Flowchart illustrates the steps and total number of studies retrieved from electronic databases.



3.3 TOTAL PARTICIPANTS

A total number of the participants from 22 eligible studies were met the inclusion criteria and was presented in the table of results, as shown in *Table 2.1 – Table 2.7*. A total of 14,989 participants who undergone TKA and received intervention programmes for functional recovery were analysed the outcomes through included eligible studies only. A study by Papalia et al. (2020) has assessed outcomes from 7,321 participants with THA, which this group of participants were excluded from the outcome analyses.

3.4 TABLES OF STUDY SUMMARY

Studies eligible for including in this quasi-systematic review were briefly explained individually in the row, which information was broken down separately by the column. The first column of the table was the list of author/researcher and year of publication of the study. Type of study was reported to describe how each study was carried out while the level of evidence (LOE) indicated how studies were conducted based on the methodological quality of study design, applicability to patient care, and validity, which could give strength to a particular study (McNair & Lewis, 2012). In this quasi-systematic and narrative review, types of evidence that were included for analyses are listed below,

1. Randomised Controlled Trials (RCTs) – a study where participants were randomly allocated to two or more groups, received different interventions, and compared outcomes. If there are two groups of patients in the study, the experimental group received the intervention while the control group received an alternative treatment, such as no intervention or placebo (Kabisch, Ruckes, Seibert-Grafe, & Blettner, 2011).
2. Systematic Review and Meta-analysis
3. Quasi-experimental Design – a study describes nonrandomised, pre- and post-intervention. This study design is typical in the medical informatics literature (Harris et al., 2006).
4. Prospective Randomised Study – this study is considered the gold standard for evaluating new treatments. Participants were screened using rigorous eligibility criteria and excluded from prospective randomised trials due to associated medical conditions and illnesses (Merlino, Malangoni, Smith, & Lange, 2001).
5. Prospective Intervention Study – this study aims to tailor an evaluation of the direct impact of treatments or preventive measures on the disease (Thiese, 2014).

6. Cohort Study – a study focuses on an assessment of a group of people who shared common characteristics within a defined period, such as the similar exposure to drug or vaccine, or undergone the same medical intervention (Song & Chung, 2010).

Average and mean age of eligible participants were 65 years and over regarding the study interested of the elderly population. Various types of post-operative exercise and rehabilitation programmes were recorded in short – clinical and functional outcomes were explained in the discussion part. Duration of interventions was briefly describing an overall timeline of rehabilitation period throughout the study. The results of post-intervention outcomes were listed and illustrated into tables; *Table 3.1 – Table 3.7*. Studies were rearranged from the most recent down to the oldest one.

Study	Type of Study, Level of evidence (LOE)	Type of Orthopaedic Procedure	Mean Age (y)	Number of Patients	Type of Post-operative Exercise and Rehabilitation	Intervention Period	Clinical/Functional Outcomes
Teissier et al., 2020	RCT LOE I	TKA	72.1 ± 6.3 years	n=20 (ECC-CON Group n=10) (CON Group n=10)	ECC-CON Resistance Training CON Resistance Training	2 daily 1-hour sessions (10 hrs/week) for 4 weeks	ECC-CON Programme: Low-moderate intensity showing better improvement in strength and functional abilities than CON and Isometric muscle strengthening programme.
Papalia et al., 2020	Systematic Review and Meta-Analysis LOE I	TKA THA	65 - 71.2 years	n=20,139 (underwent TKA n=12,818) (underwent THA n=7321)	Post-operative Physical Activity (early and late physiotherapy, aquatic therapy, and sport activity)	Varies (due to high volume of studies included)	A study suggests patients are benefit from physiotherapist activities including aquatic therapy and physical activity.
Christiansen et al., 2020	RCT LOE I	TKR (TKA)	67.0 ± 7.0 years	n=43 (Intervention Group n=20) (Control Group n=23)	Weekly steps/day goal setting by physical therapist using Fitbit Zip to track the progress.	3 weeks after TKR surgery	Increasing in physical activity (PA) level after weekly steps/day goal setting after discharged from the inpatient PT.

Table 3.1 – Overview of clinical and functional outcomes of post-operative exercise and rehabilitation programmes.

Piva et al., 2019	RCT LOE I	TKR	70.0 (7) years	n=240 (Physical Therapy n=96) (Community n=96) (Control n=46)	1. Clinical-based physical therapy exercise (physical therapy arm) 2. Community-based group exercise (community arm) 3. Usual care (control arm)	Physical therapy arms participated in exercise programmes lasting for 12 weeks, and community arm participated lasted up to 3 months.	Primary Outcomes: WOMAC-PF demonstrated no benefit of later stage exercise after TKR. Secondary Outcomes: Physical therapy arm show greater improvement among two other arms
Chou L. N. and Chen M. L., 2019	Quasiexperimental Design LOE III	TKA	most participants aged > 70 years	Predominantly Women n=50 (Experimental Group n=25) (Control Group n=25)	Elastic Band Exercise	2-4 weeks after TKA	Elastic band exercise showing improvement in the lower limb rehabilitation.
Roig-Casasus et al. 2018	RCT LOE I	TKA	73.4 (4.4) years	Remained Participants n=37 (Experimental Group n=17) (Control Group n=20)	Balance Training with Dynamometric Platform	4 weeks (total 20 sessions)	Significant improvements were shown by scoring of Berg Balance Scale and Functional Reach Test in the experimental group, better performance in Timed Up and Go Test (TUG)
Doma, Grant, and Morris, 2018	Systematic Review and Meta-Analysis LOE I	TKA	Participants in included studies aged > 65 years	n=740 (Balance Group n=373) (Conventional Group n=367)	Balance Training	4 - 32 weeks (4 studies include 6-12 months follow-up at post-interventions)	Balance training shows greater improvement than conventional group in walking capacity, balance specific performance measures, subjective measures of physical function

Table 3.2 - Overview of clinical and functional outcomes of post-operative exercise and rehabilitation programmes.

Hepperger et al., 2017	Prospective, Randomised Studies LOE II	TKA	Average age of 67 years (IG 67.4 ± 5.0) (CG 67.4 ± 5.6)	n=48 (Intervention Group n=25) (Control Group n=23)	Controlled Hiking Programme	3 months	Clinical Outcomes: no swelling or increased pain. Functional Outcomes: moederate improvement in functional abilities and quality of life (QoL)
Taniguchi et al., 2016	Prospective Intervention Study LOE I	TKA	72.1 ± 7.0 years	Included Participants n=81 (73 (90%) participants were women)	Physical Activity promoting Gait Improvement (Passive knee range of motion (ROM) exercises, strengthening, gait, activity of daily living (ADL), and cycling on stationary bicycle)	4 weeks	Clinical Outcomes: time reduced in Time Up and Go (TUG) test and Sit to Stand (STS) test. Visual Analog Scale (VAS) measuring subjective knee pain decreased significantly. Modified Gait Efficacy Scale (mGES) exhibited great improvement. Functional Outcomes: Increasing in physical activity.
Kelly et al., 2016	RCT LOE I	TKA	71.2 (6.8) years	n=38 (Low Velocity (LV) n=19) (High Velocity (HV) n=19)	Low Velocity Exercise: perform curbs and stairs at comfortable preferred speed. High Velocity Exercise: perform curbs and stairs as fast as possible while maintaining proper form.	7 weeks (12 sessions)	Both LV and HV exhibit greater improvement in functional performance rated by 6-minute walking test (6-MWT). HV group reported significant decrease in pain at the end of 6-week training programme measured by VAS.

Table 3.3 - Overview of clinical and functional outcomes of post-operative exercise and rehabilitation programmes.

Zietek et al., 2015	RCT LOE I	TKA	SP 69.5 (8.2) years IP 67.9 (7.8) years	Participants included n=62 (allocated to standard protocol (SP) n=31) (alloated to intensive protocol (IP) n=31)	15-minute walk applied right after the recovery from spinal anaesthesia on the same day.	1, 2, and 14 days (Rehabilitation was performed on the1st and 2nd day after TKA)	Participants in fast-track rehabilitation programme show no improvement in knee function and reduction in pain
Potzelsberger et al., 2015	RCT LOE I	TKA	70 ± 5 years	n=27 (Intervention Group (IG) n=13) (Control Group (CG) n=14)	Recreational Skiing Intervention on lower limb muscle strength and cardiovascular fitness	12 weeks recreation skiing intervention 22-29 skiing days (3.5 hours/session)	IG exhibits increasing in quadriceps and hamstrings muscle strength in operated leg. No effect on cardiovascular fitness.
Liao et al., 2015	RCT LOE I	TKR (TKA)	FR 73.40 (7.04) years BR 71.43 (6.33) years	n = 130 (Functional Rehabilitation (FR) n=65) (Additional Balance Rehabilitation (BR) n=65)	Balance Training	8-week rehabilitation programme	Functional Outcomes: BR group exhibit significant improvement in functional reach test, Time Up and Go (TUG) test. After intervention programme of balance training, BR group shows better balance and mobility than FR group. (improved balance could enhance mobility)

Table 3.4 – Overview of clinical and functional outcomes of post-operative exercise and rehabilitation programmes.

Ciolac et al., 2015	Cohort Study LOE II	TKA	OKG 75.3 ± 3.1 years OG 70.4 ± 5.3 years YG 23.7 ± 3.5 years	Elderly women n=23 (Older Knee Group (OKG) n=7) (Older Control Group (OG) n=8) (Young Group (YG) n=8)	Resistance Training	13 weeks	OKG exhibited lower functional performance (sit-to-stand, rising from the floor, stair climbing, and 6-MW), unilateral balance (single leg stance), and impaired loading distribution in the lower limbs compared to OG and YG.
Liao et al., 2013	RCT, Prospective Intervention Studies LOE I	TKA	EG 71.38 (6.57) years CG 72.94 (7.33) years	Participants included in analyses n=113 (Experimental Group (EG) n=58) (Control Group (CG) n=55)	Functional Training: warm-up, strengthening exercises, functional task-oriented exercises, endurance exercises, and cool-down. Additional Balance Training for EG only	8 weeks of additional balance training programme	EG showed significant improvement in 10-min walk, timed up and go (TUG) test. Plus improvement in WOMAC score.
Park, Kim, and Lee, 2012	RCT LOE I	TKA	EG 70.3 ± 3.0 years CG 69.1 ± 3.6 years	Elderly women n=44 (Experimental Group (EG) n=22) (Control Group (CG) n=22)	Conservative physical therapy intervention and modified quadriceps setting exercise (MQS) for EG Conservative physical therapy intervention and conventional quadriceps setting exercise (CQS) for CG	4 weeks	Quadriceps femoris strength for both group has increased for 80% of that before surgery. MQS can increase the activity of hamstring muscle more than CQS.

Table 3.5 – Overview of clinical and functional outcomes of post-operative exercise and rehabilitation programmes

Lowe et al., 2012	Exploratory Pilot RCT LOE I	TKA	HP 67.84 (8.45) years UP 70.76 (9.45) years	Eligible patients residing in Oxfordshire being analysed and included in the study n=98 (Home Visit Physiotherapy n=49) (Usual Physiotherapy n=49)	HP: two postdischarge home visit (within two weeks, then 6-8 weeks of discharge) UP: usual physiotherapy treatment provided by at the hospital without additional home visits.	8 weeks	Both groups show improvement in sit to stand time and timed walk test.
Jakobsen et al., 2012	Pilot Study LOE II	TKA	70 (10) years	n=13	Progressive strength training 10 repetition maximum (10 RM)	2 weeks (3 training sessions/week which rehabilitation was commenced 1 or 2 days after TKA)	Isometric knee-extension strength and maximal walking speed increases by 147% and 112%, respectively. No increasing in knee joint effusion or knee pain.
Chow, P. T. Y. and Ng G. Y. F., 2010	RCT LOE I	TKA	68.43 ± 7.95 years (group 1 66.7 (8.29) years) (group 2 69.8 (8.0) years) (group 3 70.2 (6.59) years)	Participants who have completed the study n=100 (group 1 n=32) (group 2 n=35) (group 3 n=33)	Group 1: Active Stretching Group 2: Passive Stretching Group 3: Proprioceptive Neuromuscular Facilitation Stretching	2 weeks (5 days per week)	All active, passive, and proprioceptive neuromuscular facilitation stretching increase both active and passive knee flexion range.

Table 3.6 – Overview of clinical and functional outcomes of post-operative exercise and rehabilitation programmes

Petterson et al., 2009	RCT LOE I	TKA	EG 65.2 ± 8.5 years E-NMES 65.3 ± 8.3 years	Participants who have completed the intervention and testing n=149 (Exercise Group n=81) (Exercise-NMES Group n=68)	Progressive quadriceps strengthening with/without neuromuscular electrical stimulation (NMES) and conventional rehabilitation	6 weeks (2/3 times per week)	Both groups exhibit significant outcomes of improvement in TUG, stair-climbing test, 6-minute walk, and flexion and extension ROM degree at 3-12 months postoperatively
Rossi et al., 2005	Prospective Intervention Study LOE I	TKA	73.23 ± 5.34 years	n = 38	Resistive Training	8 weeks	Isokinetic assessment revealed the greater torque production and peak force of knee extension comparing to before surgery
Moffet et al., 2004	RCT LOE I	TKA	IFR Group 66.7 ± 8.7 years CTL Group 68.7 ± 8.3 years	n=77 (IFR Group n=38) (CTL Group n=39)	Intensive functional rehabilitation (IFR) programme: warm-up, specific strengthening exercises, functional task-oriented exercises, endurance exercises, and cool-down. Control (CTL) group receiving standard care	6-8 weeks (12 supervised rehabilitation session which each period has a duration of 60-90 minutes)	IFR Group shows significant improvement in 6-MWT, WOMAC score (pain, stiffness, and difficulty), physical function measured by SF-36 scales summary.

RCT = Randomise Controlled Trial, LOE = Level of Evidence, TKA = Total Knee Arthroplasty/ TKR = Total Knee Replacement, THA = Total Hip Arthroplasty, ECC-CON = Eccentric-Concentric, CON = Concentric, PT = Physical Therapy, PA = Physical Activity, WOMAC = Western Ontario McMaster Universities Arthritis Index, TUG = Timed Up and Go, QoL = Quality of Life, STS = Sit to Stand, VAS = Visual Analogue Scale, mGES = Modified Gait Efficacy Scale, 6-MWT = 6-Minute Walking Test, ROM = Range of Motion

Table 3.7 – Overview of clinical and functional outcomes of post-operative exercise and rehabilitation programmes

3.5 TABLE OF PEDRO SCALE ASSESSMENT

The criteria of studies selection and quality assessment was based on the PEDro Scale, which was used to rate the quality of RCTs in studies regarding physical therapist interventions. All 20 studies eligible for using PEDro analyses were rated and listed in the table as shown in *Table 3.8 and Table 3.9,* where two studies by Papalia et al. (2020) and Doma, Grant, and Morris (2018) were excluded from the PEDro scale assessment due to the nature of the study being a systematic review and meta-analysis.

Eligible studies included in this quasi-systematic review and narrative review were being critically assessed the quality by only single investigator utilising the PEDro scale analyses, 11 criteria were the baseline of scoring if each study meets the criteria. Points will be awarded when a criterion was clearly satisfied. If the trial report were not satisfied with the criterion, a point would not be awarded for that criterion. Scoring methods were clarified below with each specific criterion was clarified.

1. Criterion 1 – Score will be given if the study clearly describes the source of subjects and criteria used to determine the eligible participants in the study.
2. Criterion 2 – If a study has clearly stated random allocation of the participants where the precise method of randomisation was explained, a score will then be given.
3. Criterion 3 – If the person who determined the eligibility of a subject to be included in the trial was unaware of which group of subjects will be allocated to when the decision was made. Even the allocation was not stated as concealed, but the study states that allocation was given by sealed opaque envelopes, this would still consider as concealed allocation, and a point will also be awarded.
4. Criterion 4 – The report must describe at least one measure of the condition being treated and at least one outcome measure at baseline. If baseline data of study including are presented, the criterion is also satisfied.

5. Criterion 5 – The criterion is satisfied if the included subjects in the studies were blinded.
6. Criterion 6 – The criterion is satisfied if therapists who administered the therapy were blinded.
7. Criterion 7 – The criterion is satisfied if assessors who measured key outcome were blinded.
8. Criterion 8 – The score will be given if the study apparently states the number of participants initially allocated to a group and the number of participants which the key outcome measures were obtained, plus key outcome measured more than 85% of participants.
9. Criterion 9 – The criterion is satisfied even the analysis by intention to treat was not mentioned, the score still is given if the study clearly states all subjects received treatment or control conditions as allocated.
10. Criterion 10 – The score will be given if the results of a comparison between groups (intervention and control groups) are reported for at least one key outcome.
11. Criterion 11 – The criterion is satisfied if the study provides both point measures and variability measures for at least one key outcome. A point measure is the measurement of the size of the treatment effect; this could be described as a difference in group outcomes or the outcomes of all groups. Whilst measures of variability composed of confidence intervals, standard deviation (S.D.), standard errors, interquartile ranges, and ranges.

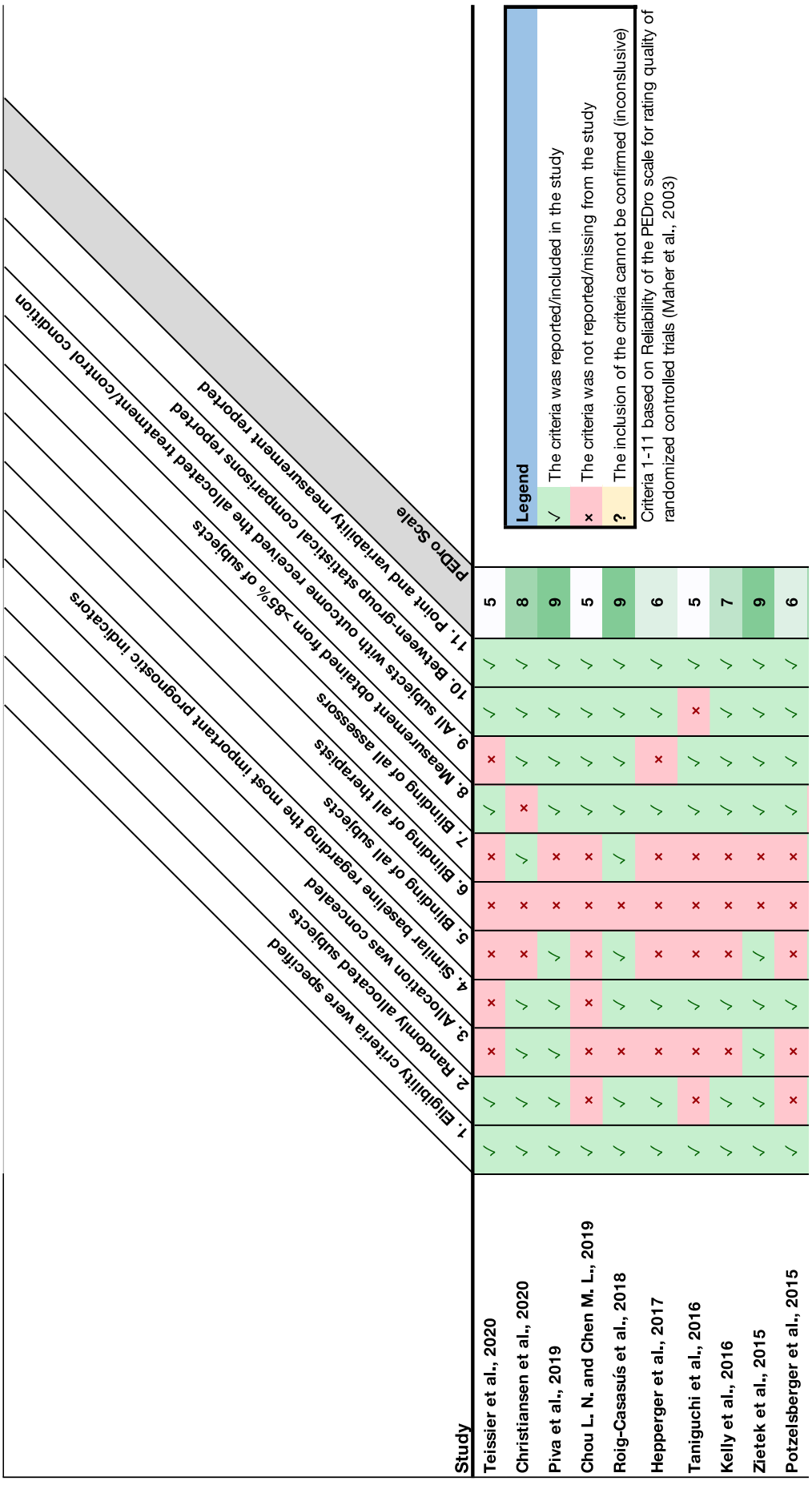


Table 3.8 PEDro Scale Assessment

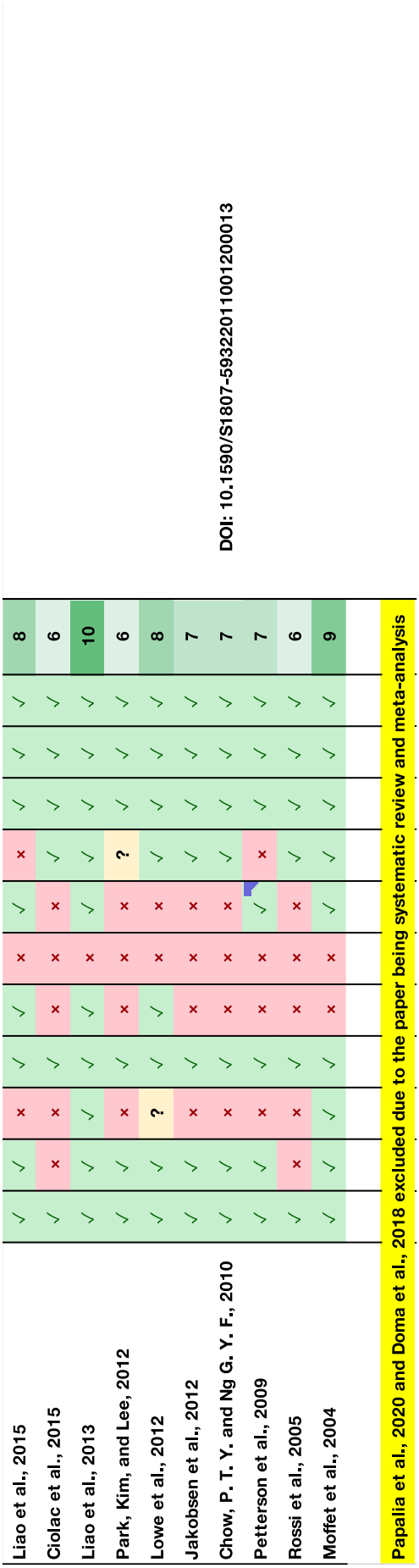


Table 3.9 PEDro Scale Assessment

3.6 POST-OPERATIVE EXERCISE AND REHABILITATION

Various physiotherapist interventions derived by the full-text assessment of the included studies were listed separately below.

1. Eccentric-Concentric (ECC-CON) resistance training and Concentric (CON) resistance training (Teissier, Leclercq, Schiano-Lomoriello, Nizard, & Portier, 2020).
2. Post-operative physical activity including physiotherapy, aquatic therapy, and sport activity (Papalia et al., 2020).
3. Weekly steps/day goal setting using Fitbit Zip to track the progress (Christiansen et al., 2020).
4. Clinical-based physical therapy exercise, community-based group exercise, and usual care (Piva et al., 2019).
5. Elastic band exercise (Chou & Chen, 2019).
6. Balance training with a dynamometric platform (Roig-Casasus, Blasco, Lopez-Bueno, & Blasco-Igual, 2018).
7. Balance training (Doma et al., 2018).
8. Controlled hiking programme (Hepperger et al., 2017).
9. Physical activity promoting gait improvement (Taniguchi et al., 2016).
10. High velocity exercise and low velocity exercise (Kelly, Finley, Lichtman, Hyland, & Edeer, 2016).
11. 15-minute-walk on the day of surgery to fast-track rehabilitation (Zietek, Zietek, Szczypior, & Safranow, 2015).
12. Recreational skiing intervention (Potzelsberger et al., 2015).
13. Balance training (Liao et al., 2015).
14. Resistance training (Ciolac, Silva, & Greve, 2015).
15. Balance training (Liao, Liou, Huang, & Huang, 2013).

16. Modified quadriceps femoris muscle setting exercise (Park, Kim, & Lee, 2012).
17. Post-discharge physiotherapy versus usual care (Lowe, Barker, Holder, & Sackley, 2012).
18. Progressive strength training 10-repetition maximum (10 RM) (Jakobsen, Husted, Kehlet, & Bandholm, 2012).
19. Active, passive and proprioceptive neuromuscular facilitation stretching (Chow & Ng, 2010).
20. Progressive Strengthening Interventions (Petterson et al., 2009).
21. Resistive training (Rossi, Brown, & Whitehurst, 2005).
22. Intensive functional rehabilitation and standard care (Moffet et al., 2004).

Included studies have different rehabilitation approaches in post-operative exercise recovery programme; however, there are some included studies that have implemented somewhat similar rehabilitation programmes. First of all, studies by Doma et al. (2018), Liao et al. (2013), Liao et al. (2015), and Roig-Casasus et al. (2018) have implemented balance training programme for the elderly patients, which the method and duration of balance training are varied across four different studies. Moreover, three studies by Ciolac et al. (2015), Rossi et al. (2005), and Teissier et al. (2020) have implemented resistance training programme to patients. From this observation, balance and resistance training are the most common post-operative exercise programme that have been implemented to participants comparing to every other included study that shows different rehabilitation programmes. All studies have both experimental and control groups where at least both groups of participants must have undergone rehabilitation programme or usual care equally, except participants in experimental groups will receive post-operative exercise programme adjunct to usual rehabilitation programme.

3.7 CLINICAL OUTCOMES

As the results from all 22 eligible studies included, clinical outcomes were reported, however, it is also essential to include functional and other outcomes which play an important role by representing the results of post-intervention.

3.7.1 Clinical Outcomes and Functional Outcomes

1. Teissier et al. (2020)

Clinical and Functional Outcomes: The study yielded the results of significant decreasing of TUG and 10mWT, by 71.5% and 41% respectively in ECC-CON intervention, whilst CON intervention did not show significant improvement. Isokinetic assessment on both groups exhibits great improvement in peak torque on the operated leg for the hamstring muscle. After intervention was completed, ECC-CON group exhibit a better outcome of operated hamstring muscle peak torque than CON group by 26.3%. Moreover, both ECC-CON and CON groups exhibit a significant improvement in ROM; knee flexion by +18% and 10%, and knee extension by -45% and -44%, respectively. Visual analogue scale (VAS) for pain assessment was decreased significantly in both groups. WOMAC score reveals significant improvements in elf-reported physical function and QoL for both group either. Kinesiophobia was reported to be decreased for all patients in ECC-CON group whereas only 6 patients have decreased Kinesiophobia, and contrary for other 4 patients in CON group.

Intervention Duration: 2 daily 1-hour sessions (10 hrs/week) for 4 weeks.

2. Papalia et al. (2020)

Clinical Outcomes and Functional Outcomes: Aquatic rehabilitation in the elderly patients with TKA shows significant improvement in WOMAC index, quadriceps strength, walking speed, and stair-ascending time. Due to current available studies, moderate physical activity could improve clinical outcome in ROM. However, ergometer cycling show zero improvement in both outcomes, and could potentially injure the operated leg also.

Intervention Duration: Not mentioned and could be varied depending on each specific study.

3. Christiansen et al. (2020)

Functional Outcomes: Intervention groups engaged in Fitbit Zip tracking revealed an increasing in a mean of 1,798 steps/day more than control group that received a standard care. Patients completed an intervention programme exhibit more time engaging in moderate-vigorous PA/week, including higher number of steps/day. At post-intervention, ROM of knee flexion and extension degree was improved, and VAS exhibit a decreased in pain after completing the recovery programme.

Intervention Duration: 3 weeks.

4. Piva et al. (2019)

Clinical Outcomes: Both clinical-based and community-based interventions exhibit an improvement in WOMAC index. However, implementation of rehabilitation in later-stage exercise did not show improvement in WOMAC index. No adverse effects being reported at the end of rehabilitation.

Intervention Period: Clinical-based physical therapy exercise for 12 weeks and community-based group exercise 2 classes/week, 24 classes in total which was lasted to 3 months, while usual care for control group were asked to joint intervention programme by voluntary.

5. Chou and Chen (2019)

Clinical Outcomes: Increasing in active and passive knee flexion ROM, and quadriceps muscle strength in the experimental group. After 2 weeks of intervention at post-TKA, participants undergone rehabilitation exhibit significant strengthening of the lower limb muscle power for hamstrings, and quadriceps, and greatly reduced knee pain.

Functional Outcomes: Experimental group receiving elastic band exercise exhibited higher physical function than the control group.

Intervention Period: 2 – 4 weeks

6. Roig-Casasus et al. (2018)

Clinical and Functional Outcomes: Comparing experiment group (EG) using dynamometric platform to control group (CG) of participants without using dynamometric platform in balance training. EG exhibits significant improvement in Berg Balance Scale (BBS) and Functional Reach Test (FRT) greater than those in CG. Both groups have improved TUG without showing significant difference between group,

Intervention Period: 30 sessions for 4 weeks training programme.

7. Doma et al. (2018)

Clinical and Functional Outcomes: Participants completed balance training programme exhibit better significant improvement in walking capacity, balance-specific performance measures, and subjective measurement of physical functions than conventional training. Two groups of participants have no difference in ROM and pain score observed.

Intervention Period: Included studies ranged from 4 – 32 weeks, where 4 studies have performed 6 – 12 months follow-up after intervention.

8. Hepperger et al. (2017)

Clinical and Functional Outcomes: Intervention group achieved a faster walking time for Stair Climbing Test (SCT); the time for stair ascending has decreased from pre- to post-test by 4.3 ± 0.6 to 3.6 ± 0.4 seconds and for stair descending has also decreased from pre- to post-test by 3.6 ± 0.6 to 3.2 ± 0.5 seconds, respectively. Moderate improvement in pain and QoL were reported at post-intervention.

Intervention Period: 3-month hiking programme.

9. Taniguchi et al. (2016)

Clinical and Functional Outcomes: Physical activities of passive knee range of motion exercise, gait strengthening, daily living activities, cycling on stationary bicycle yield resulting in time reduced in Time Up and Go (TUG) test and Sit to Stand (STS) test. Visual Analog Scale (VAS) measuring subjective knee pain is decreased

significantly. Modified Gait Efficacy Scale (mGES) exhibited gait improvement, plus increasing in physical activity was reported.

Intervention Period: 4 weeks

10. Kelly et al. (2016)

Clinical and Functional Outcomes: Low velocity (LV) exercise: perform curbs and stairs at comfortable preferred speed whereas high velocity (HV) exercise performs curbs and stairs as fast as possible while maintaining proper form. Both LV and HV exhibit significant improvement in

1. TUG – both LV and HV groups exhibit decreasing in TUG time from a pre- and post-test by 18.5 and 18.5 seconds to 10.8 and 10.4 seconds, respectively.
2. SCT - both LV and HV groups exhibit decreasing in overall SCT time from a pre- and post-test by 42.2 and 39.0 seconds to 21.6 and 20.2 seconds, respectively.
3. VAS - both LV and HV groups exhibit minimising in pain at post-test.

Intervention Period: 12 sessions within 7 weeks of training.

11. Zietek et al. (2015)

Clinical Outcomes: Fast-track rehabilitation implementing 15-minute walking on the first and second day after surgery did not show any improvement in knee function, knee flexion and extension, thus pain level neither increased nor decreased.

Intervention Period: 1, 2, and 14 days (Rehabilitation was performed on the1st and 2nd day after TKA for fast-track rehabilitation group)

12. Potzelsberger et al. (2015)

Clinical Outcomes: This study gave the results of increasing of muscle strength in operated leg (OP) during isokinetic single limb strength and isometric extension testing, decreasing in asymmetry indices (AIs) on OP leg and non-operated leg (NOP), however, no cardiovascular improvement was observed after the intervention. Focusing on an outcome of muscle strength adaptation, in isokinetic strength testing, OP leg has increased 8% of quadriceps muscle without changes observed in NOP leg.

Intervention Period: 22-29 skiing days of recreational skiing intervention 12 weeks (3.5 hours/session)

13. Liao et al. (2015)

Functional Outcomes: Comparison between balance rehabilitation group and functional rehabilitation group on interested outcomes showing better results of FRT, single-leg-stance test, 10-minute walking (10-MW) test, TUG test, SCT, and WOMAC index, which indicate that balance rehabilitation is more suitable in the elderly patients than functional rehabilitation. In addition, improving both single leg balancing, and functional reaching are associated with better outcomes of improved mobility and self-reported physical functioning.

Intervention Period: 8 weeks of intervention programme.

14. Ciolac et al. (2015)

Functional Outcomes: There is no significant difference of observed in between group of older knee group (OKG), older control group (OG), and young control group (YG). After the rehabilitation, no injuries and muscle damage or joint pain associated

with the resistance training programme were reported during the study among three groups of participants. However, outcomes of intervention in OKG exhibit lowered functional performance (sit-to-stand, rising from the floor, stair climbing, and 6-MW), unilateral balance (single leg stance), and impaired loading distribution in the lower limbs compared to OG and YG. All participants recruited in this study were female.

Intervention Period: 13-week of resistance training programme.

15. Liao et al. (2013)

Functional Outcomes: Experimental group undertook conventional function training with addition of balance training demonstrated significant improvements in 10-min walk, timed up and go (TUG) test, and WOMAC score comparing to control group with conventional function training only.

Intervention Period: 8-week additional balance training.

16. Park et al. (2012)

Clinical Outcomes: Quadriceps femoris strength for both groups have increased for 80% of that before surgery. MQS can increase the activity of hamstring muscle more than CQS.

Intervention Period: 4-week of conservative physical therapy intervention and modified quadriceps setting exercise (MQS) for EG, and conservative physical therapy intervention and conventional quadriceps setting exercise (CQS) for CG.

17. Lowe et al. (2012)

Functional Outcomes: No significant difference found between groups. Outcomes reported for both groups were improvement in Oxford Knee Score, time decreased in STS and TUG.

Intervention Period: 8-week programmes of home visit physiotherapy performing two post-discharge home visits (within two weeks, then 6-8 weeks of discharge), and usual physiotherapy treatment provided by at the hospital without additional home visits.

18. Jakobsen et al. (2012)

Clinical and Functional Outcomes: Isometric knee-extension strength and maximal walking speed increases by 147% and 112%, respectively. No increasing in knee joint effusion or knee pain.

Intervention Period: 2-week progressive strength training 10 repetition maximum (10 RM) (3 training sessions/week which rehabilitation was commenced 1 or 2 days after TKA).

19. Chow and Ng (2010)

Clinical Outcomes: Three different stretching programmes assigned to three groups of participants completed, all participants exhibit an improvement in ROM for knee flexion and extension.

Intervention Period: 2-week active, passive, and proprioceptive neuromuscular facilitation stretching.

20. Petterson et al. (2009)

Clinical and Functional Outcomes: Both groups exhibit significant outcomes of improvement in TUG, stair-climbing test, 6-minute walk, and flexion and extension ROM degree at 3-12 months postoperatively.

Intervention Period: 6 weeks of progressive quadriceps strengthening with/without neuromuscular electrical stimulation (NMES) and conventional rehabilitation.

21. Rossi et al. (2005)

Clinical Outcomes: Isokinetic assessment revealed the greater torque production and peak force of knee extension comparing to before surgery.

Intervention Period: 8 weeks of resistance training.

22. Moffet et al. (2004)

Clinical and Functional Outcomes: Intensive functional rehabilitation (IFR) programme including, warm-up, specific strengthening exercises, functional task-oriented exercises, endurance exercises, and cool-down, control (CTL) group receiving standard care. IFR Group shows significant improvement in 6-MWT, WOMAC score (pain, stiffness, and difficulty), physical function measured by SF-36 scales summary better than CTL group.

Intervention Period: 6-8 weeks of 12 supervised rehabilitation session which each period has a duration of 60-90 minutes.

All included studies have been assessed and analysed the clinical outcomes at post-operative exercise, apart from clinical outcomes, functional outcomes are also essential to be observed. Even though balance training exhibited improvement in both clinical and functional outcomes; however, different approaches in rehabilitation programme could lead to a speedy recovery. For example, Roig-Casasus et al. (2018) have used a dynamometric platform as an addition to the balance training for 4 weeks of training, which clinical outcomes exhibited significant improvement in TUG similar to 8-week balance training by Liao et al. (2015) and Liao et al. (2013). This could indicate that balance training with addition of dynamometric platform could provide an effective improvement in clinical outcomes with shorter period of intervention required. Moreover, resistance training could provide significant improvement in lower functional performance (LFP), including STS, rising from the floor, stair climbing, muscle strength, and one-leg stance. Besides beneficial aspects of resistance training, not every elderly participant could benefit from this training as mentioned. Ciolac et al. (2015) have revealed a result from female participants with average age of 75 years, which showed the impaired loading in the lower limbs. Plus, some intervention could provoke the recurrence of injury in the past, which this will be elaborate in the discussion part. All in all, most interventions are effective, feasible, and safe for the elderly patients; however, history of injury must be assessed individually prior implementing such intervention programmes in order to minimise the risk of injury during exercise.

3.8 RISK OF BIAS ASSESSMENT

Risk of bias protocols was adapted to this study where appropriate. Studies were assessed through a scaling system, including high risk, unclear risk, and low risk was based and adapted from the Cochrane Risk of Bias Assessment in RCTs (Higgins et al., 2011). An essential aspect of bias assessment could indicate potential flaws, which was probably made by the previous assessors or researchers of that study. The bar graph reveals an overall potential bias of 20 included non-systematic review and meta-analysis studies, as shown in *Figure 3.2*.

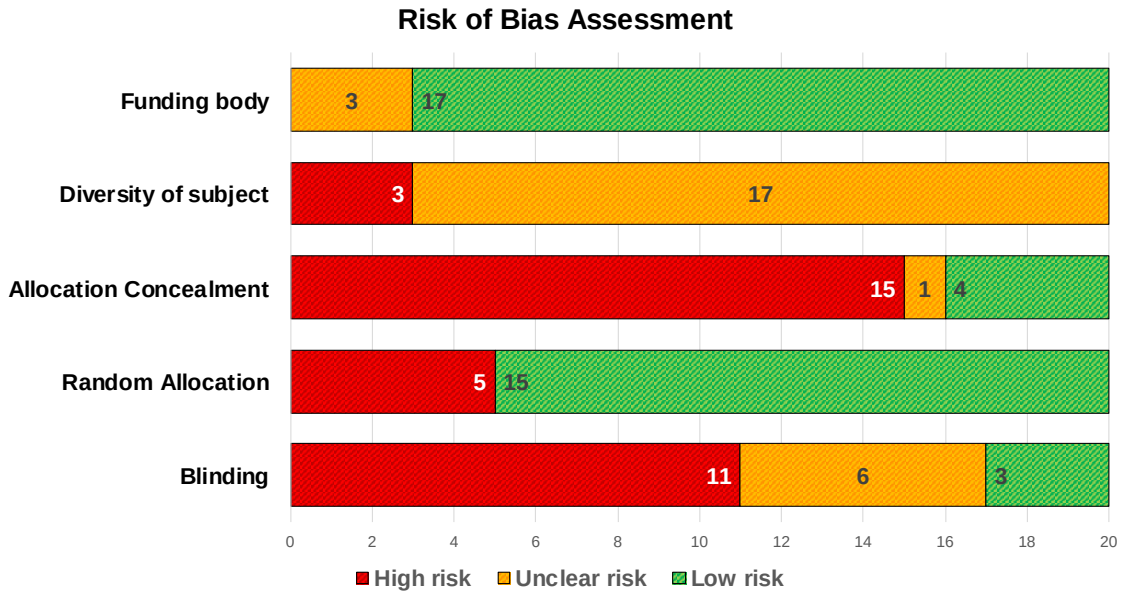


Figure 3.2 Risk of Bias Assessment (an overview of included studies regarding implementation of rehabilitation in the elderly patients with TKA).

CHAPTER 4

4.1 DISCUSSION

This study is focusing on the post-operative exercise and rehabilitation by dismissing the pre-operative exercise or prehabilitation in order to be specific to the research question and type of interventions. Eligible studies that were included in this study will be discussed the benefit, strength and weakness of the study, and reliability of the results.

Overall, screened studies in the field of physiotherapy that have been included in this review were focusing on physical improvement of the elderly patients at post-TKA. Studies have shown various promising effects after the intervention, the elderly patients have shown to be improved in both clinical and function outcomes at different levels based on the type of rehabilitation programme they undergone.

Some challenges that previous researchers have found throughout the study are physical limitations of participants, withdraw from the study, loss of contact and follow-up, and deceased due to ageing. Small number of patients were unable to perform some types of post-operative exercise due to past medical history of injury or increasing in pain. Partial loss and missing of data are due to loss of contact, which researchers are not able to contact and make progress. Nevertheless, some patients were reported death, which the data of a dead individual must be unaccounted from the study.

4.2 LIMITATION OF THE STUDY

This study has a limitation, which there is only one investigator who carried out the screening process. A systematic review generally composed of at least two or more investigators who independently assess all literature and make a recommendation for its inclusion criteria. There is a certainty that there could be a potential bias as there is only one investigator during the screening process; therefore, it was decided that bias could be slightly mitigated by the single investigator carrying out multiple screening proofs and comparing their own first and second attempts. In the future, a project carried out by the research team would ideally include multiple investigators who would independently assess each article for inclusion and exclusion criteria in the review to reduce a bias possibility.

4.3 OUTCOMES OF INTERVENTION PROGRAMMES FOR RECOVERY

This review was based purely from the included eligible studies in this review retrieved by using specific keywords on electronic database searching. One of the most common rehabilitation applied to the elderly patients at post-surgery is balance training (Roig-Casasus et al., 2018) (Doma et al., 2018) (Liao et al., 2015) (Liao et al., 2013). Doma et al. (2018) stated notable improvement in walking capacity, balance-specific performance measures, and subjective measurement of physical functions. Balance training with dynamometric platform exhibit remarkable improvement in BBS, TUG, and FRT. BBS is an indicator showing participants the ability to walk autonomously and assessing the risk of falling (Roig-Casasus et al., 2018). FRT was used to detect balance and changes in physical performance over time, to measure the maximum distance when the participant is reaching forward to a distance point while standing in a fixed position. To conclude, according to Liao et al. (2015), balance rehabilitation is considered to be more feasible in the elderly participants than functional rehabilitation based on an improvement in FRT, single-leg-stance test, 10-minute walking (10-MW) test, TUG test, SCT, and WOMAC index. Lastly, a comparison of the experimental group (EG) receiving conventional training with additional balance training programme to control group (CG) with conventional training by Liao et al. (2013), functional outcomes was recorded significant improvement in the 10-min walk, TUG test and WOMAC index in EG more than CG, which exerted beneficial effects in functional recovery and mobility for the elderly patient with KOA undergone TKA.

Considering feasibility, fidelity, and safety of the intervention, steps/day track on walking should be one of the most appropriate physical rehabilitation for the elderly patients, which an intensity could be modified depending on the ability of patients and appropriate time for intervention at post-surgery. Additionally, elastic band exercise is also feasible

in elderly patients. Chou and Chen (2019) reported a significant improvement in hamstrings and quadriceps muscles after completing a rehabilitation programme, notably, improving knee pain, as well as recreational skiing intervention (Potzelsberger et al., 2015). In extent, a study by Jakobsen et al. (2012) stated that the progressive strength training ten repetition maximum for the elderly patients with TKA could enhance isometric knee-extension strength and maximal walking speed by 147% and 112%, respectively, without causing knee joint effusion or knee pain. Furthermore, home visit physiotherapy performing two post-discharge home visits (within two weeks, then 6-8 weeks of discharge), and usual physiotherapy treatment provided by at the hospital without additional home visits, functional outcomes also demonstrated time reduction in TUG and STS (Lowe et al., 2012). This home visit physiotherapist programme is suitable for elderly patients with physical independence and low mobility to receive standard medical care of a guided rehabilitation programme.

Furthermore, controlled hiking programme (Hepperger et al., 2017) is also safe and feasible for the elderly patients, as the results show zero detrimental effects at post-intervention. Thus, SCT shows a promising effect of improvement in functional ability for stair climbing, where stair ascending, and descending time was decreased. Controversially, according to Zietek et al. (2015), implementing 15-minute walking on the first and second day of TKA as fast-track rehabilitation did not exhibit any functional improvement at post-intervention; thus neither increase nor decrease pain level. Therefore, there is still some evidence provided which was considered as non-effective in the rehabilitation process for the elderly patients. Even though a study by Kelly et al. (2016) regarding high velocity and low velocity exercise. After intervention programmes completed, the results are positive in TUG, SCT, and VAS pain assessment. TUG and SCT revealed less time taken to complete the task at post-intervention when compared to

pre-intervention period and VAS score also shown decreasing in pain level for both HV and LV groups. However, the study has reported minor adverse effect to participants, where 7% of participants in HV groups required a decreasing of resistance intensity to continue an intervention programme. Negatively, one participant across the study experienced a recurrence of previous episodic sciatica during the study. Patients' history of treatment is one of the most important factors which should be carefully considered when applying physiotherapist intervention that might have a risk to evoke the previous chronic diseases related to the musculoskeletal system in elderly participant.

Oppositely, not all interventions are considered to be beneficial and useful for elderly patients. A systematic review and meta-analysis by (Papalia et al., 2020) mentioned the adverse outcomes in overloading of ergometer cycling and not considered to be a suitable intervention for the elderly patients (Liebs et al., 2010). Stationary recovery in the control group of participants shows a little improvement in their physical function. Prolonged sedentary behaviour could potentially lead to joint stiffness, immobility, muscle weakness, and lowered in QoL. In addition, resistance training intervention in the female elderly participants yields the result of lowered functional performance (sit-to-stand, rising from the floor, stair climbing, and 6-MW), unilateral balance (single leg stance), and impaired loading distribution in the lower limbs in OKG compared to OG and YG (Ciolac et al., 2015).

Additionally, Kinesiophobia is one of the psychological factors which could be useful to be assessed as it has the potential to induce sedentary behaviour to patients (Teissier et al., 2020). Mentally, if the elderly patients are not confident with their movement after post-intervention due to stiffness and pain on the weight-bearing joint, this could possibly contribute to a prolonged condition of lacking mobility at discharge from the hospital.

These findings are currently available in a limited number of studies, further investigation of outcome measures is required in order to make a consensus on feasible and safe physical intervention at post-surgery for the elderly population undergone TKA.

4.4 CRITICAL APPRAISAL OF INCLUDED STUDIES

The PEDro scale can be used for quality identification of each study. A short-list below shown how the PEDro score tells the quality of a study.

1. PEDro score 6-10 points – a study is considered as high quality.
2. PEDro score 4-5 points – a study is considered as fair quality.
3. PEDro score ≤ 3 points – a study is considered as poor quality.

Included studies in this review were considered as fair to high quality based on the scoring criteria shown in the *table 3.1 and 3.2*. There are three studies that were categorised as fair quality and 17 studies as high quality. Moreover, another two systematic review studies were considered as high-quality study based on LOE and nature of the study. However, studies should be analysed and screened carefully as ambiguous sentences could lead to misinterpretation of the method and inconclusive result, which was indicated as a question mark in the table. All in all, quality assessment of included studies was based entirely on the PEDro scale analysis, which was the most common and standardised tool for assessing studies regarding the field of physiotherapy.

4.5 RISK OF BIAS ASSESSMENT

Five factors were adapted and based on PEDro scale analysis to assess potential biases from each study, such as blinding, random allocation of participants, allocation concealment, diversity of participants, and funding body. This quasi-systematic and narrative review utilise risk of bias assessment to analyse the overview of the total number of studies, to investigate bias of the study in the field of physiotherapist in the elderly patient undergone TKA.

Risk of bias was applied across all included studies in this review, which different studies exhibited different types of possible bias and examples of studies will be explained following each point below.

4.5.1 Blinding

Initially, in terms of blinding, conducting research in a field of physiotherapy, most eligible studies included were barely blind all participants, therapists, and assessors. The most apparent issue found in blinding assessment that this study found, it is impossible to blind therapists during the intervention as they are primarily responsible for addressing the treatment to subjects. Therefore, therapists in the study will notice how intervention applied and the protocols that have been addressed to participants. Moreover, one of the significant problems is blinding assessment in participants. A study by Lowe et al. (2012) has mentioned an unclear blinding method which opaque envelopes were given to participants regarding baseline assessment by assessors. However, patients have opened an envelope, resealed, and return their envelopes – making blinding results remained inconclusive, which a question mark was annotated.

4.5.2 Random Allocation of Participants

If participants were randomly allocated, this condition means that every participant in the study was equally received a treatment or an intervention. Mainly, allocation of participants is vital to avoid bias in the way which the experiment was carried out. A study without random allocation will be marked as high risk due to a potential bias, which participants were allocated to specific condition with intention.

4.5.3 Allocation Concealment

This process was performed to prevent selection bias in RCTs by allocation concealment, the process of allocation was concealed throughout assigning participants to the intervention groups. This could prevent researchers from making any influential decision in assigning, which participants should belong to intervention or control group. In this process, it is important to make a careful screening and interpretation as, for example, a study by Lowe et al. (2012) revealed that envelopes were given to the patients, which patients opened, resealed, and returned their envelopes of arranging treatment delivery. Therefore, making the clarity of process questionable; thus, being annotated as unclear bias.

4.5.4 Diversity of Analysed Subjects

Diversity of participants could contribute to inconclusive of treatment effectiveness due. Studies by Chou and Chen (2019) and Lowe et al. (2012) where participants were being recruited from southern Taiwan and Oxfordshire, the UK only. The outcomes did not represent participants besides these groups of participants. Therefore, conducting a research in a larger population is recommended to obtain representative and valuable

results. Another 17 studies did not clearly mention specifically where the participants were recruited from, so they're marked as unclear.

4.5.5 Funding Body

Some studies that were being sponsored by the external funder. A study could be considered as high risk when funding has been made, which outcomes of the studies could be influenced to become successful in order to satisfy the funders of the study. According to (Lexchin, 2012), in the pharmaceutical industry, a major conflict found from the company funding on clinical research is the conflict of trying to produce a good science result that could enhance sales of the product. Moreover, research funded by industry could potentially undermine the confidence in medical knowledge.

Based on bias assessment in this review, a funded study was marked as "unclear bias". However, the funding body did not always conclude that a funded study is definitely biased. It is critically important for assessors/researchers to analyse, assess, and screen carefully in order to avoid misinterpretation. There are 2 studies of systematic review that were not included in this graph.

CHAPTER 5

5.1 CONCLUSION AND FUTURE RESEARCH

To sum up, at present, inventing the gold standard for post-operative exercise and rehabilitation is incredibly challenging in physiotherapist care. Most of the interventions are majorly practical, safe, and feasible to almost all age groups of patients, except the elderly patients. Even though balance training reported in this study demonstrated many positive and promising effects in the recovery process at post-TKA, however, the data represented in this review is partially a preliminary result and insufficient to draw a final conclusion for the gold standard training protocols. Physical weakness and fragility natures of the elderly patients should be prioritised before implementing such intervention programmes, as Liebs et al. (2010) has reported on adverse outcomes of pain and QoL and showed zero improvements at post-intervention. Therefore, definite outcomes of intervention programmes for the elderly patients undergone TKA are not one hundred percent certain at present, retrieving more significant number of high quality and trustable research in this field is essential to produce a standard protocol.

Nevertheless, in the future, more significant number of studies from a variety of participants from different places and backgrounds might be possible to draw a final conclusion of the gold standard for physiotherapist protocols, which could be useful in medical care globally.

APPENDIX

Timeline of the study

Due to COVID-19 pandemic, the previous research project on the topic of "Biomechanical Analysis of Force Distribution in the Ankle and Injury Risk in the Lateral Malleolus and the Knee Joint during Lay-up Maneuvers in Basketball" was forced to modify to different research approaches as motion analysis laboratory was no longer available since March 2020. The final decision to conduct a quasi-systematic and narrative review as a final thesis was made on June 2020, plus the presentation was given on the 2nd TMC Meeting. Therefore, the original deadline for thesis submission was set on January 2021. However, as I must complete my degree within a strictly limited amount of time in order to further my study at the University of Edinburgh. Therefore, my new deadline was set on Thursday, 17th September 2020.

Tasks	**Timeframe**	
	Start date	**End date**
2nd TMC Meeting	-	20th June 2020
Learned how to conduct a systematic review and meta-analysis on the futurelearn.com	1st July 2020	25th July 2020
Generated new research type and question	26th July 2020	1st August 2020
Perform electronic database searching and retrieve electronic data	2nd August 2020	3rd August 2020
Reviewing all undertaken online courses to conduct a quasi-systematic and narrative review.	4th August 2020	10th August 2020
Performed screening of all retrieved studies	11th August 2020	23rd August 2020
Included/Excluded for relevant studies of interested	24th August 2020	31st August 2020
Start writing the whole report and generate tables and graphs	1st August 2020	16th September 2020

Completing and reviewing every part of the thesis	16th September 2020	17th September 2020
Submit the Final Thesis		17th September 2020

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